



Assignment 1
CSI2120 Programming Paradigms
Winter 2017

Due on February 6th, 2017 before 11:00 pm in Virtual Campus

[5 marks in total]

Question 1. Search Tree [1.5 mark]

Consider the following Prolog program:

```
r1 (X) :- f2 (X) , ! .  
r1 (X) :- f1 (X) , r1 (Y) , f3 (Y) .  
r2 (X, Y) :- f3 (Y) , r1 (Y) , f1 (X) .  
f1 (a) .  
f1 (b) .  
f2 (c) .  
f2 (a) .  
f3 (c) .  
f3 (a) .  
f3 (b) .
```

Reminder: A search tree shows in each node, the current goal to be satisfied. The edges are labeled with the unifications taking place in the transition from one node to the next. The leaves node are either still showing goal(s) or are empty. Empty leaves mark a solution. The tree is read from top to bottom and from left to right.

Your answer to the questions below must be drawn correctly to receive the corresponding marks for the question.

a) Draw the complete search tree for the following query:

`?- r2 (a, B) .`

b) How many solutions are there to the query in a) if the cut in the predicate r1/1 is removed, i.e., if we change the rule

```
r1 (X) :- f2 (X) , ! .
```

to the modified rule

```
r1 (X) :- f2 (X) .
```

Question 2. Happy Numbers [2 marks]

Consider the digits $d_k, d_{k-1}, \dots, d_1, d_0$ of a positive integer number. The squares of the digits are then $d_k^2, d_{k-1}^2, \dots, d_1^2, d_0^2$ and we name the sum of these squares s . We can create a recursive series of the squares of the digits of positive integers. This series will be $s_0, s_1, s_2, s_3, \dots$ where s_0 is the sum of squares of the original number, s_1 the sum of the squares of the digits of s_0 , s_2 the sum of the squares of the digits of s_1 , and so on.

- a) Create a rule `sosd/2` which calculates the sum of square digits. Example:

```
?- sosd(130, Y) .
Y = 10;
false
```

- b) If the sum of squares of the digits of a numbers $s_i = 1$ for any i then the starting number s_0 (and all numbers s_1, \dots, s_{i-1}) are called happy numbers. Write a rule that determines if a number is happy. For any starting number, this series always reaches one of 10 numbers: 0,1,4,16,20,37,42,58,89,145 (OEIS A039943; Porges 1945). Create a predicate with base cases for the series such that your calculation stops once any of the numbers is reached. Your predicate `happyNumber/1` must print the number that is reached and caused it to stop. It should be true if the number is happy and false otherwise. Print out the stopping number with `writeln/1`.

Example:

```
?- happyNumber(31) .
1
true.
```

```
?- happyNumber(42) .
20
false.
```

Question 3. Databases [1.5 marks]

Enter the plants listed at the end of this question into a Prolog database of garden plants. You will have to design the database and decide on the name for constants and predicates.

- a) Add a rule which finds hardy plants (zone less than 6) that can grow at least to a height of 48in and are perennials.
?- hardy(P) .
- b) Add a rule trio/6 to your database that will allow you to get three **different** plants with the requested colors.
?- trio(red,X,white,Y,blue,Z) .
- c) Extend your database to suggest plants for Paul and Mary. Note that Mary does not like yellow and Paul likes plants that may grow to 36in. Paul and Mary live in zone 7.
?- suggestion(paul(X),mary(Y)) .

Garden plants:

Blue Lobelia, partial sun, shade, sun, blue, 6-12in., zones 2-11, annual

Impatiens, shade, 12-36in., red, white, pink, zones 10-11, annual

Periwinkle, partial sun, shade, sun, blue, 0-6in., zones 4-9, perennial

Anemone, partial sun, sun, pink, white, 12-36in., zones 4-8, perennial

Marigold, sun, yellow, orange, 3-12in., annual

Black-eyed susan, partial sun, sun, yellow, 12-24in., zones 3-11, annual

Bleeding heart, partial sun, shade, pink, white, 6-12in., zones 3-9, perennial

Chrysanthemum, partial sun, sun, red, yellow, blue, white, 12-36in., zones: 5-9, perennial

False Lupine, partial sun, sun, yellow, 12-96in., zones: 4-8, perennial

Heather, partial sun, sun, purple, 36-96in., zones 6-10, perennial

Iris, partial sun, sun, blue, orange, pink, red, white, 6-36in, zones: 3-9, perennial

Phlox, purple, red, pink, 12-36in., zones 2-11, annual